

CLAIMS:

1. An autothermal reactor for the generation of a hydrogen-containing product gas stream from a feed gas stream, the autothermal reactor comprising:

5 a reactor vessel having a feed gas stream inlet end and a product gas outlet end;

a partial oxidation catalyst located within the reactor vessel and positioned in the path of the feed gas stream;

10 a steam methane reforming catalyst located within the reactor vessel and positioned downstream from the partial oxidation catalyst in the path of the feed-gas stream;

15 a first inlet means to introduce a first feed gas stream component selected from the feed gas component stream group comprising a hydrocarbon fuel, oxidant, and steam, the first inlet means located at the fuel gas stream inlet end of the reactor vessel; and

means to pulsate associated with the first inlet means to pulsate the flow of the first feed gas stream component into the autothermal reactor.

20 2. The autothermal reactor of claim 1 further comprising a second inlet means to introduce a second feed gas stream component selected from the feed gas component stream group comprising a

hydrocarbon fuel, oxidant, and steam, the second feed gas stream component being different from the first feed gas stream component, the second inlet means being located at the fuel gas stream inlet end of the reactor vessel.

5

3. The autothermal reactor of claim 2 further comprising a third inlet means to introduce a third feed gas stream component selected from the feed gas component stream group comprising a hydrocarbon fuel, oxidant, and steam, the third feed gas stream component being different from the first feed gas stream component and the second feed gas stream component, the third inlet means being located at the fuel gas stream inlet end of the reactor vessel.

4. The autothermal reactor of claim 3 wherein the first feed gas stream component is a hydrocarbon fuel, the second feed gas stream component is oxidant, and the third feed gas stream component is steam.

5. The autothermal reactor of claim 3 wherein the first feed gas stream component is oxidant, the second feed gas stream component is hydrocarbon fuel, and the third feed gas stream component is steam.

6. The autothermal reactor of claim 1 wherein the reactor vessel includes a mixing zone for the mixing of the feed gas component stream, the mixing zone being located upstream of the partial oxidation catalyst.

5

7. The autothermal reactor of claim 6 wherein the mixing zone consists of a series of non-catalyzed monolith slices spaced apart, such that the resonance time within the slice-space combination is from 50% to 200% of the cycle time of the pulsing.

10  
15  
20  
25  
30  
35  
40  
45  
50  
55  
60  
65  
70  
75  
80  
85  
90  
95  
100  
105  
110  
115  
120  
125  
130  
135  
140  
145  
150  
155  
160  
165  
170  
175  
180  
185  
190  
195  
200  
205  
210  
215  
220  
225  
230  
235  
240  
245  
250  
255  
260  
265  
270  
275  
280  
285  
290  
295  
300  
305  
310  
315  
320  
325  
330  
335  
340  
345  
350  
355  
360  
365  
370  
375  
380  
385  
390  
395  
400  
405  
410  
415  
420  
425  
430  
435  
440  
445  
450  
455  
460  
465  
470  
475  
480  
485  
490  
495  
500  
505  
510  
515  
520  
525  
530  
535  
540  
545  
550  
555  
560  
565  
570  
575  
580  
585  
590  
595  
600  
605  
610  
615  
620  
625  
630  
635  
640  
645  
650  
655  
660  
665  
670  
675  
680  
685  
690  
695  
700  
705  
710  
715  
720  
725  
730  
735  
740  
745  
750  
755  
760  
765  
770  
775  
780  
785  
790  
795  
800  
805  
810  
815  
820  
825  
830  
835  
840  
845  
850  
855  
860  
865  
870  
875  
880  
885  
890  
895  
900  
905  
910  
915  
920  
925  
930  
935  
940  
945  
950  
955  
960  
965  
970  
975  
980  
985  
990  
995

8. The autothermal reactor of claim 1 wherein the partial oxidation catalyst is selected from the group consisting of a nickel-based catalyst, a precious metal-based catalyst, and a precious metal-based catalyst with a metal-oxide promoter.

9. The autothermal reactor of claim 1 wherein the partial oxidation catalyst is configured as pellets.

10. The autothermal reactor of claim 1 wherein the partial oxidation catalyst is configured as monoliths.

11. The autothermal reactor of claim 1 wherein the steam methane reforming catalyst is a metal-oxide-based catalyst.

12. The autothermal reactor of claim 1 wherein the means to pulsate first feed gas stream component flow is a flow control element.

5 13. The autothermal reactor of claim 12 wherein the flow control element is an actuator operated flow control valve whose actuator is cyclically driven between two predetermined positions by a pre-programmed control logic.

10 14. The autothermal reactor of claim 12 wherein the flow control element is an actuator operated flow control valve whose actuator is cyclically driven between two predetermined positions by a mechanically linked feed-back system which throttles or opens the flow-control valve in inverse relationship to the pressure.

15 15. The autothermal reactor of claim 12 wherein the flow control element is an feedback loop based flow-control valve whose actuator is cyclically driven between two predetermined positions by incorporating a zero-dampening factor in its feed-back control system.

20

16. The autothermal reactor of claim 1 wherein the means to pulsate the first feed-gas stream component flow is a rotating gas

compressor whose operation develops pulsed flow characteristics.

17. The autothermal reactor of claim 1 wherein the means to  
pulsate first feed-gas stream component flow is a peristaltic flow  
movement device.

18. The autothermal reactor of claim 1 further comprising  
downstream components to further process the gases; and said  
downstream components are designed to propagate the pulsed flow  
characteristics developed in the ATR into the fuel cell to enhance  
CO tolerance of the fuel cell.

19. The autothermal reactor of claim 1 further comprising  
downstream components to further process the gases; and said  
downstream components are designed to dampen pulsed flow  
characteristics developed in the ATR such that it does not  
propagate into the fuel cell.

20. A method of generating a hydrogen-containing product gas from  
an autothermal reactor containing a partial oxidation catalyst and  
a steam methane reforming catalyst, the method comprising the steps  
of:

pulsatingly introducing a feed gas mixture comprising a first

feed gas stream component selected from the feed gas component group comprising a hydrocarbon fuel, oxidant, and steam into the autothermal reactor;

passing the feed gas mixture over the partial oxidation catalyst to produce a partially oxidized product gas stream;

passing the feed gas mixture over the steam methane reforming catalyst to generate the hydrogen-containing product gas stream; and

removing the hydrogen-containing product gas stream generated from the autothermal reactor.

21. The method as claimed in claim 20 further comprising introducing into the autothermal reactor a second feed gas stream component selected from the group comprising a hydrocarbon fuel, oxidant, and steam, the second feed gas stream component being different from the first feed gas stream component, and mixing the first and second feed gas stream components to produce the feed gas mixture.

22. The method as claimed in claim 21 further comprising introducing into the autothermal reactor a third feed gas stream component selected from the group comprising a hydrocarbon fuel, oxidant, and steam, the third feed gas stream component being

different from the first feed gas stream component and the second feed gas stream component; and mixing the first, second and third feed gas stream components to produce the feed gas mixture.

5 23. The method as claimed in claim 22 wherein the first feed gas stream component is a hydrocarbon fuel, the second feed gas stream component is an oxidant and the third feed gas stream component is steam.

10 24. The method as claimed in claim 22 wherein the first feed gas stream component is oxidant, the second feed gas stream component is a hydrocarbon fuel, and the third feed gas stream component is steam.

15 25. The method as claimed in claim 20 wherein the partial oxidation catalyst is selected from the group consisting of a nickel-based catalyst, a precious metal-based catalyst, and a precious metal-based catalyst with a metal-oxide promoter.

20 26. The method as claimed in claim 20 wherein the partial oxidation catalyst is configured as pellets.

27. The method as claimed in claim 20 wherein the partial

oxidation catalyst is configured as monoliths.

28. The method as claimed in claim 20 wherein the pulsating  
introduction of the first feed-gas stream component flow is created  
5 by a flow control element.

29. The method as claimed in claim 28 wherein the pulsating  
introduction creates a peristaltic flow movement.

10  
20  
30  
40  
50  
60  
70  
80  
90  
100  
110  
120  
130  
140  
150  
160  
170  
180  
190  
200  
210  
220  
230  
240  
250  
260  
270  
280  
290  
300  
310  
320  
330  
340  
350  
360  
370  
380  
390  
400  
410  
420  
430  
440  
450  
460  
470  
480  
490  
500  
510  
520  
530  
540  
550  
560  
570  
580  
590  
600  
610  
620  
630  
640  
650  
660  
670  
680  
690  
700  
710  
720  
730  
740  
750  
760  
770  
780  
790  
800  
810  
820  
830  
840  
850  
860  
870  
880  
890  
900  
910  
920  
930  
940  
950  
960  
970  
980  
990  
1000